

CLAIMS:

What is claimed is:

1. A pipe-bursting apparatus for use with a drill string, the apparatus comprising:

a frame connectable with the drill string; and

5 at least one substantially spherical pipe-bursting member supported by the frame and operable in response to movement of the drill string.

2. The apparatus of claim 1 wherein the frame comprises a substantially conical housing.

3. The apparatus of claim 1 comprising a plurality of substantially spherical members supported by the frame.

4. The apparatus of claim 3 wherein the frame comprises a longitudinal axis and wherein the plurality of spherical pipe-bursting members are longitudinally aligned on the frame.

5. The apparatus of claim 3 wherein the frame comprises a longitudinal axis and wherein the plurality of spherical pipe-bursting members are radially disposed about the frame and in a plane substantially perpendicular to the longitudinal axis of the frame.

6. The apparatus of claim 1 further comprising at least one pipe cutter blade operatively connected to the frame.

7. The apparatus of claim 1 comprising a rod rotatably supported within the frame.

8. The apparatus of claim 7 wherein the frame comprises a longitudinal axis and wherein the rod comprises a drive member adapted to move the spherical pipe-bursting member linearly with the longitudinal axis.

9. The apparatus of claim 7 further comprising a pipe-cutting member supported by the rod and external to the frame, and wherein the pipe-cutting member is operable in response to rotation of the rod.

10. The apparatus of claim 7 further comprising a race supported by the rod for rotation therewith and adapted to roll the spherical pipe-bursting member.

11. The apparatus of claim 7 wherein the frame defines an opening and wherein the spherical pipe-bursting member is moveable through the opening, the apparatus further comprising:

5 an eccentric cam supported on the rod for rotation therewith and
 adapted to move the spherical pipe-bursting member through
 the opening of the frame.

12. The apparatus of claim 7 further comprising a flywheel supported by the rod to vibrate the spherical pipe-bursting member.

13. The apparatus of claim 1 further comprising a percussive tool connectable with the frame.

14. A horizontal directional drilling system comprising:
a drive machine;
a drill string, having a first end and a second end;
wherein the first end of the drill string is operatively connected to the
5 drive machine;
a pipe-bursting apparatus operatively connected to the second end of
the drill string, the apparatus comprising:
a frame operatively connected to the drill string; and
at least one substantially spherical pipe-bursting member
10 supported by the frame and operable in response to
movement of the drill string.

15. The horizontal directional drilling system of claim 14 wherein
the frame comprises a substantially conical housing.

16. The horizontal directional drilling system of claim 14
comprising a plurality of substantially spherical members supported by the frame.

17. The horizontal directional drilling system of claim 16 wherein
the frame comprises a longitudinal axis and wherein the plurality of spherical pipe-
bursting members are supported by the frame axial with the longitudinal axis.

18. The horizontal directional drilling system of claim 16 wherein
the frame comprises a longitudinal axis and wherein the plurality of spherical pipe-
bursting members are radially disposed about the frame in a plane substantially
perpendicular to the longitudinal axis of the frame.

19. The horizontal directional drilling system of claim 14 wherein
the pipe-bursting apparatus further comprises at least one pipe cutter blade operatively
connected to the frame.

20. The horizontal directional drilling system of claim 14 wherein the pipe-bursting apparatus comprises a rod rotatably supported within the frame.

21. The horizontal directional drilling system of claim 20 wherein the frame comprises a longitudinal axis and wherein the rod comprises a drive member adapted to move the spherical pipe-bursting member linearly with the longitudinal axis.

22. The horizontal directional drilling system of claim 20 further comprising a pipe-cutting member supported by the rod and operable in response to rotation of the rod.

23. The horizontal directional drilling system of claim 20 further comprising a race supported by the rod for rotation therewith and adapted to roll the spherical pipe-bursting member.

24. The horizontal directional drilling system of claim 20 wherein the frame defines an opening and wherein the spherical pipe-bursting member is advancable through the opening, the pipe-bursting apparatus further comprising:

5 an eccentric cam supported on the rod for rotation therewith and
 adapted to advance the spherical pipe-bursting member through
 the opening of the frame.

25. The horizontal directional drilling system of claim 20 wherein the rod comprises a flywheel disposed within the frame to cause vibration of the spherical pipe-bursting member.

26. The horizontal directional drilling system of claim 14 wherein the drill string comprises an outer member and an inner member disposed longitudinally within the outer member, and wherein the inner member is rotatable independently of the outer member.

27. The horizontal directional drilling system of claim 26 wherein the frame of the pipe-bursting apparatus is connectable to the outer member of the drill string, and wherein the pipe-bursting apparatus comprises a rotatable rod supported on the frame and connectable to the inner member of the drill string.

28. The horizontal directional drilling system of claim 26 wherein the frame comprises a housing having at least one opening; wherein the pipe-bursting apparatus further comprises a rod rotatably supported within the housing and operable in response to rotation of the inner member of the drill string, wherein the spherical
5 pipe-bursting member is movable to an advanced position through the opening in response to rotation of rod.

29. The horizontal directional drilling system of claim 26 wherein the pipe-bursting apparatus comprises at least one pipe-cutting member operatively connected to the frame and operable in response to movement of the outer member.

30. The horizontal directional drilling machine of claim 27 wherein the frame comprises an internal channel and wherein the rod comprises threads adapted to transport the spherical pipe-bursting member longitudinally along the internal channel.

31. The horizontal directional drilling system of claim 26 further comprising a pipe cutter section assembly connectable with the outer member of the drill string, wherein the frame is operatively connected to the inner member of the drill string for rotation therewith to drive operation of the pipe-bursting apparatus.

32. The horizontal directional drilling system of claim 26 further comprising a downhole hammer assembly operatively connectable with the pipe-bursting apparatus.

33. The horizontal directional drilling system of claim 27 wherein the rod comprises a pipe-cutting member having a plurality of cutting teeth operable in response to rotation of the rod.

34. The horizontal directional drilling system of claim 27 wherein the outer member of the drill string comprises a biasing tool assembly operable in response to rotational movement of the outer member.

35. The horizontal directional drilling system of claim 27 wherein the pipe-bursting apparatus further comprises a race supported by the rod and operable in response to movement of the rod to drive operation of the spherical pipe-bursting member, and wherein the frame is operably connected to the outer member
5 of the drill string to position and orient the pipe-bursting apparatus.

36. The horizontal directional drilling system of claim 26 wherein the inner member of the drill string comprises a drill string drive and wherein the pipe-bursting apparatus comprises a rod drive supported by the rod and adapted to matingly engage the drill string drive to rotate the rod in response to rotation of the
5 inner member.

37. The horizontal directional drilling system of claim 36 wherein the rod drive comprises a rod drive gear adapted to matingly engage a gear supported on the rod of the pipe-bursting apparatus.

38. The horizontal directional drilling system of claim 14 wherein the frame comprises a longitudinal axis and wherein the drill string comprises a longitudinal axis, wherein the frame is connectable with the drill string so that the longitudinal axes of the frame and the drill string are substantially parallel.

39. A method for bursting pipe using a horizontal directional drilling system including a rotary drive machine, a drill string having a first end and a second end, wherein the first end is operatively connected to the rotary drive machine, a pipe-bursting apparatus operatively connected to the second end of the drill string,
5 the pipe-bursting apparatus comprising a frame and a spherical pipe-bursting member supported by the frame, the method comprising:

operating the spherical pipe-bursting member by moving the drill string.

40. The method of claim 39 further comprising:
positioning the pipe-bursting apparatus by advancing, withdrawing, or rotating the drill string.

41. The method of claim 39 wherein operating the spherical pipe-bursting member comprises rotating the drill string.

42. The method of claim 39 wherein the drill string comprises an outer member and an inner member disposed within the inner member and rotatable independently of the outer member, wherein the pipe-bursting apparatus comprises a rod connectable with the inner member of the drill string, and wherein the frame is
5 connectable with the outer member of the drill string, the method comprising:

axially advancing and rotating the outer member of the drill string to position the pipe-bursting apparatus; and
rotating the inner member of the drill string to drive operation of the spherical pipe-bursting member.